SECTION IX

FINAL DESIGN

GENERAL

According to Missouri State Statutes, plans for public roadwork must be prepared by or under the immediate personal supervision of a registered professional engineer.

Plans and specifications must be prepared in such a manner that payment in the contract will be made on the basis of units of work and materials.

In addition to the drawing submittals information defined in **Section VIII**, "Preliminary Design" (and **Figure VIII-7**), the final design drawings shall include the information defined in the "Bridge Drawings" portion of this Section and on the "Final Design - Bridge Submittals Checklist", **Figure IX-3.** **Reduced plans (11"x17") are to be provided for MoDOT review with the PS&E submittals.**

Plans and specifications prepared by the engineer will be reviewed by MoDOT on an individual project basis only and may not be assumed to apply to other similar projects. Design computations do not need to be submitted to MoDOT unless requested. However, vehicle load rating computations that meet AASHTO requirements as well as the requirements described in this Section are required to be submitted for review.

ROADWAY

There is no set standard for the order of sheets within the roadway portion of the plans. Items that must be included are typical sections, plan, profile, or plan and profile sheets, special sheets, erosion control plans, traffic control plans, and cross section sheets or data. Other sheets to be included if applicable include culvert sheets, lighting, signals, signing, utility sheets if part of the roadway contract, and standard plans.

Information that should be on the plan, profile, or plan and profile sheets should include a north arrow, graphic scale, description of the project's beginning and ending points, construction details, alignment and profile data, bench marks, and any construction notes. Construction notes should not be placed in the cross section sheets.

STORMWATER AND EROSION CONTROL

Provisions of the federal Clean Water Act and related state rules and regulations require stormwater permits where construction activities disturb areas greater than five acres. MoDOT has a general permit (obtained from MoDNR) that allows them to accomplish road construction activities. The permit stipulates that MoDOT will follow certain erosion control guidelines and install temporary erosion control measures. This permit applies only to land disturbance activities associated with MoDOT construction projects and does not include locally sponsored projects.

A few cities (Kansas City, Columbia, and others) and counties have made application to MoDNR and have obtained their own land disturbance permits for generic land disturbance purposes. In these areas, the project sponsor (city or county government) would have their own restrictions and erosion control guidelines to meet the intent of their program.

Prior to initiation of any federal aid project, the local sponsor needs to determine the acreage that will be disturbed. If less than five acres is disturbed, the sponsor is exempt from the requirements of the Federal Clean Water Act National Pollutant Discharge Elimination System Permits (NPDES) program and MoDNR permit applications. However: there may be other local ordinances that must be addressed. The sponsor should inquire whether or not there are local rules and regulations that govern clean water guidelines.

If greater than five acres are to be disturbed, the project sponsor should determine if their city or county is operating under a MoDNR approved program. If so, appropriate erosion controls will be imposed by the local government jurisdiction. If the city or county does not have a MoDNR stormwater program, the sponsor shall contact MoDNR (Water Pollution - 573-751-1300) for further directions.

If any amount of acreage is to be disturbed, the Local Agency shall be responsible for providing a temporary erosion control plan to be included with the final plan submittal. The plans shall detail the types of temporary erosion control facilities to be used and the location of where the items shall be installed. Further information on the design criteria can be found in the AASHTO Highway Drainage Guidelines, Volume III, “Erosion and Sediment Control in Highway Construction, 1992.”

TRAFFIC CONTROL

A traffic control plan must be developed and included in the plans and specifications for the safe handling of traffic through or around the construction of each project. The basis for traffic control should be the Manual on Uniform Traffic Control Devices (MUTCD) and the MoDOT Traffic Control for Field Operations Manual. The scope of the traffic control plan should match the complexity of the project.

Projects should have a qualified person designated to have the responsibility and authority for assuring that the traffic control plan and other safety aspects of the contract are being followed. The plans and specifications should include pay items for providing, installing, moving, replacing, maintaining, cleaning, and removing traffic control devices required by the traffic control plan.

BRIDGE DESIGN CRITERIA

1. ***Design Specifications***

Minimum acceptable structure design standards shall be governed by the current "Standard Specification for Highway Bridges" published by the 2002 AASHTO Standard Specifications for Highway Bridges, 17th Edition.

Design computations will only be requested when the structure is an unusual type or if there is reason to question the economy or safety of the structure.

2. ***Seismic Investigation***

All bridge structures in seismic categories A, B, C and D shall be designed according to the current *Standard Specification for Highway Bridges* published by AASHTO, or an equivalent criteria. **Figure IX-1** indicates the acceleration coefficients for use in seismic design.

3. ***Structural Inventory and Appraisal Sheet, Vehicle Load Rating Calculations and Load Rating Summary***

The Structure Inventory and Appraisal Sheet with vehicle load rating calculations for newly constructed bridges and culverts must be completed in accordance with the current *Bridge Inspection Rating Manual* published by MoDOT, the *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges*, by FHWA (can be accessed at the Internet web site address **www.fhwa.dot.gov/bridge/mtguide.pdf**) as well as the *Manual for Condition Evaluation of Bridges*, AASHTO, 1994 and Interim Revisions through 2000.

A blank form for the Structural Inventory and Appraisal Sheet is included in the MoDOT *Bridge Inspection and Rating Manual*. The SI&A Sheet is also available at the MoDOT Internet address for the LPA Manual, **www.modot.org/business/localpublicagency.htm** under “Commonly Used Forms”. (When printing the SI&A Sheet from the Internet site with Adobe Acrobat, check the “expand small pages to paper size” box under “print” options to obtain a full size print).

Load rating calculations are required for all structures that will be classified as a "bridge" on the National Bridge Inventory (as defined in the above references). Inventory and Operating Load Ratings shall be provided for the AASHTO HS20 design loading. Load rating calculations for any structure carrying vehicular traffic shall also account for all MoDOT standard load posting vehicles (the H20 and 3S2 vehicles). For bridges or culverts located within the limits of commercial zones, a load posting recommendation for the commercial loading shall be included, utilizing the MO5 vehicle. All ratings are to be done using the Load Factor Rating Method. A Load Rating Summary Sheet, signed and sealed by a

Missouri Registered Professional Engineer, shall clearly list all of the determined controlling load ratings, indicated in tons. The Load Rating Summary Sheet shall indicate all information needed for the completion of the Load Rating and Posting portion of the SI&A Sheet and the load rating calculations shall provide the information necessary to support the data indicated on the Summary Sheet. (Also see **Figure IX-3**).

4. ***Bridge Railing Systems***

   a. All bridge barrier railing systems must meet appropriate crash test "TL" requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 as defined in **Section VIII**. See Section VIII, "Barrier Railing Systems" for detailed information regarding barrier railing system requirements, options available to Local Agencies and their engineers in the selection of barrier railing systems and identification of barrier railing system information that is to be included in the PS&E submittals.

   b. Detail sheets for Missouri Standard concrete rail, thrie beam, bridge rail, approach anchor section, guardrail, and terminal end sections are available from MoDOT.

BRIDGE DRAWINGS (Also see Final Design - Bridge Submittals Checklist, **Figure IX-3**)

1. MoDOT Bridge Division's *Bridge Manual* covering design and detail of prestress double tee, prestress I-beam and other type structures, including steel may be used as an aid and is available from MoDOT for a fee. The information in the Bridge Manual is also accessible via the MoDOT Internet address: **www.modot.org/business/bridgedesign.htm**

2. Detail sheets are available for many superstructure details and substructure units. These may be obtained from MoDOT, in hard copy or electronic version, for a fee - or, may be accessed at www.modot.org/business/bridgestandards.htm

3. If a concrete box culvert structure is appropriate, a single, double, or triple culvert may be built using *Missouri Standard Plans for Highway Construction* in conjunction with an additional front sheet for the double and triple box culverts to be completed with information from the standard plans. The standard plans and appropriate front sheet may be obtained from MoDOT for a fee - or, may be accessed at the following address: www.modot.org/business/standardplans.htm

4. In addition to information on the drawings already described for the Preliminary submittals stage, drawings provided with the PS&E submittals shall address those items identified in the Final Design - Bridge Submittals Checklist, **Figure IX-3**.

ESTIMATES

An engineer's estimate, showing estimated quantities, unit prices, and extended totals shall be submitted to MoDOT with the detailed plans. Subtotals shall be shown for roadway items, signals, lighting, signing, striping, and bridges. The use of lump sum format will not be allowed. The bid proposal will also need to include an itemized listing of all pay items included in the project, quantities of each individual pay item and blanks for the contractor to submit a unit price (and extension) for each pay item. Non-participating work (work that is not eligible for federal participation) shall be identified in the estimate. Any non-reimbursable utility work shall be separated from utility work that is eligible for participation.

The engineer's estimate should be treated as a confidential document. Any knowledge of the estimate may cause unbalanced bids or provide a contractor who has knowledge of the engineer's estimate an advantage.

WORK BY LOCAL FORCES

As indicated in the Code of Federal Regulations, the contract method based on competitive bidding shall be used for performance of highway work financed with the aid of federal funds unless it can be demonstrated that some other method is more cost effective. When a local agency desires that highway construction work financed with the aid of federal funds be undertaken by local forces, a request must be submitted identifying and describing the following:

1. the project and the kind of work to be performed,

2. the estimated costs,

3. the estimated federal funds to be provided, and

4. the reason or reasons that force account for such project is considered cost effective.

Work by local forces is considered to be the direct performance of work by the contracting agency or its designee utilizing labor, equipment, materials, and supplies furnished by the agency and used under its direct control. When the local agency desires to construct any portion of the project with its own forces, it must be in the public interest that this is the most cost effective way to construct the project (the efficient use of labor, equipment, materials, and supplies to assure the lowest overall cost). Local agencies must demonstrate to MoDOT that they have the equipment and experience to perform the items of work specified. MoDOT shall determine that the organization to undertake the work is so staffed and equipped as to perform such work satisfactorily and cost effectively.

There are two methods by which the local agency can be reimbursed for this type of work, and the estimate should be prepared accordingly. The first method is actual cost. Payment will be made for labor, materials and equipment rental rates. Estimated hours and rates should be included and final reimbursement will be made based on an audit of actual costs.

The other method is agreed to unit prices. This method requires more extensive justification at the PS&E stage, but reimbursement will be made based on the number of units constructed. This eliminates some record keeping and detailed audit. The agreed unit prices must be developed using quantities, man-hours, pay rates, material costs and equipment rental rates. The local agency by agreeing to these unit prices also agrees that no construction change order can be made to adjust the unit prices, but a construction change order is allowable for quantity changes. If the local agency and MoDOT can't come to an agreement on the unit price, the local agency can still perform the work by using the actual cost method described above.

MoDOT will not approve work by the local agency's forces unless it can be demonstrated that it can be accomplished at lower cost than if performed by contract. If the local agency determines they do not want to perform an item, they can negotiate a change order with the contractor to perform the work and execute a construction change order. The local agency will need to execute a work by local forces proposal (**Figure IX-2**) that should be submitted with the construction estimate.

SPECIFICATIONS AND JOB SPECIAL PROVISIONS

The engineer shall use the current publication *Missouri Standard Specifications for Highway Construction*, 1999 and Supplemental Specification Revisions, by MoDOT. The engineer may modify these specifications, where appropriate for job-specific requirements or conditions, by creating job special provisions. The Missouri Standard Specifications for Highway Construction, 1999 and Supplemental Specification Revisions shall be referenced on both the drawings and the specifications package as the basic standard for materials and construction - except as modified or superceded by job special provisions or other MoDOT-approved specifications included in the specifications package. When the Missouri Standard Specifications for Highway Construction are supplemented by job special provisions or substituted by other MoDOT-approved specifications, the cover sheet of the supplementary or substituting specifications package is to be signed and sealed by the engineer. (Only standard specifications that have been endorsed by MoDOT may be used as an alternate to the Missouri Standard Specifications for Highway Construction).

MoDOT specifications can be made available to local agencies as either a reference or for actual use in contracts. Certain job special provisions are available from MoDOT for a nominal fee; however, MoDOT Job Special Provisions and Standard Specifications information can also be accessed at the MoDOT Internet address: **www.modot.org/business/index.htm**

Local agencies are urged to prepare the specifications and special provisions carefully to ensure that the inspection, testing, and sampling procedures are adequately covered.

When the local agency decides not to inspect at the fabricators shop, the following specifications regarding acceptance of fabricated structural members shall be included in the specification documents (as Job Special Provisions), as applicable to the following categories of structural members:

Acceptance of Precast Double Tee, I-Girder, Box-Girder and Slab Panels

The following procedures have been established for the acceptance of precast double tee, I-girder, box-girder and slab panels. Shop drawings shall be submitted to the engineer for review and approval. The approval will cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in the shop drawings. The local agency or their consultant has the option of inspecting the precast units during fabrication or requiring the fabricator to furnish a certification of contract compliance and substantiating test reports. In addition, the following reports will be required:

1. Certified mill test reports, including results of physical tests on the prestressed strands, and reinforcement as required.

2. Test reports on concrete cylinder breaks.

The local agency or consultant must verify and document that dimensions of the units were checked at the job and found to be in compliance with the shop drawings.

Acceptance of Structural Steel

The following procedures have been established for the acceptance of structural steel. Shop drawings shall be submitted to the engineer for review and approval. The approval will cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in the shop drawings. The contractor shall utilize a fabricator that meets the appropriate American Institute of Steel Construction (AISC) certification provisions as stated in Section 712.3.1.6 of the 1999 Missouri Standard Specifications for Highway Construction. All welding operations, including material and personnel, shall meet the American Welding Society (AWS) specifications. The local agency or their consultant has the option of inspecting the steel units during fabrication or requiring the fabricator to furnish a certification of contract compliance and substantiating test reports. In addition, the following reports will be required:

1. Certified mill test reports, including results of chemical and physical tests on all structural steel as furnished; and

2. Non-destructive testing reports.

The local agency or consultant must verify and document that dimensions of the units were checked at the job and found to be in compliance with the shop drawings.

(Additional information regarding the AISC Certification provisions may be found at the AISC Internet web site address: **www.aisc.org**)

Acceptance of Prefabricated Structures

Performance based specifications for accepting a prefabricated bridge are not acceptable for projects requesting reimbursement from FHWA funds. The concept of alternate prefabricated products is acceptable if the engineer indicates three or more companies that can provide an acceptable product after review acceptance. We suggest that there are three ways to provide construction plans and specifications for a prefabricated structure.

1. Design all aspects of the structure needed and provide full detail plans, including construction specifications. The fabricator is required to provide the contractor and engineer with shop drawings for review prior to building the units.

2. The engineer will prepare detail plans that provide the critical geometric shape and a full set of design and construction specifications. We require the engineer to identify a minimum of three alternate fabricators in advance for the contractor to choose from that can provide an acceptable design and final product after review acceptance. The fabricator is required to provide the design computation, design drawings, both signed and sealed by a professional engineer, and shop drawings for review and approval prior to building. The contractor should be informed that MoDOT will require a 2 week review period after the design engineer accepts the plans.

3. The contractor may bid the project as let and then propose a value-engineering plan for review with no guarantee of acceptance. This method requires the concept design and detail plans, to be submitted for review and acceptance as per the MoDOT Standard Specification. The contractor shall share any cost saving with the LPA at a rate of 50-50. After concept acceptance, the contractor shall submit the design computations and detail plans, both signed and sealed by a professional engineer, to the engineer for review. The contractor should be informed that MoDOT will require a 2 week review period after the design engineer accept the plans.

It is no longer required that Shop Drawings be signed and sealed by a professional engineer for most jobs. However, this change will not be applicable for projects where the contractor may be responsible for the design at the shop drawing stage, e.g., MSE walls, precast culverts, and steel trusses. The use of trade names in plans and specifications is not allowed. MoDOT may approve the use of trade names provided at least 3 different brands are specified and if acceptable equivalents are allowed. Less than 3 specified material or product may be approved if MoDOT concurs in a finding that it is in the public interest. For instance, a local agency may find it desirable to limit traffic signal controllers to one brand for ease of maintenance and the stocking of repair parts. If the local agency wishes to use less than 3 trade names, the following justification will need to be provided to MoDOT for review/approval:

1. Show how the item(s) is essential for synchronization with the existing roadway facility or that no equally suitable alternative exists.
2. Show how the use of the product(s) will prove to be cost-effective. This should include historical data supporting the cost effectiveness of the products.
3. Show how using the product(s) will provide ease of maintenance.
4. Provide more detail on its spare parts inventory on what impact using the trade name products(s) will have on this inventory (where applicable).
5. Provide more detail on standardization – that is, provide estimated quantity of product that was implemented in areas surrounding the product (also include the date when the trade name product was implemented) (where applicable).

If the single source material cannot be justified, the item will be non-participating unless bidding procedures are used that establish the unit price of each acceptable alternative, in which case participation will be based on the lowest price established.

INSPECTION BY MoDOT AND FHWA

The project Job Special Provisions or drawings shall stipulate that MoDOT and FHWA may make inspections of the work and that the contractor shall grant them access to all parts of the work.

In general, MoDOT will not make inspections on projects costing less than $25,000 until the project is ready for final inspection. On projects costing $25,000 to $75,000, a minimum of one inspection will be made prior to the final inspection. On projects costing more than $75,000, not less than two inspections will be made prior to the final inspection. Representatives of MoDOT will make a final inspection on all projects, preferably at the same time as the local agency makes final inspection.

PLANS, SPECIFICATIONS AND ESTIMATE (PS&E) SUBMITTAL

When the plans, specifications, and the engineer's estimate of cost have been completed, the Local Agency shall submit the "PS&E" documents to MoDOT for review. (**See Figure IX-3 for the Final Design - Bridge Submittals Checklist of items to be addressed in the submittals**).

Four sets of plans, specifications and estimate should be submitted to MoDOT. If the project contains a bridge, the completed Structure Inventory and Appraisal Sheet, the vehicle Load Rating Summary Sheet (signed and sealed by the engineer) and load rating calculations must also be submitted at this time. The title sheet of the drawings must be signed by the Local Agency and all plan sheets signed and sealed by the appropriate professional before MoDOT will provide approval of the submittals. **Submitted drawings are to be half-size (11" x 17").** When the Missouri Standard Specifications for Highway Construction are supplemented by job special provisions or substituted by other MoDOT-approved specifications, the cover sheet of the supplementary or substituting specifications package is to be signed and sealed by the engineer.